Address of the President, Sir J. J. Thomson, O.M., at the Anniversary Meeting, November 30, 1920.

The list of Fellows on the Home List who have died since the last Anniversary Meeting includes the names of

Lord Walsingham.
Sir William Osler.
Sir Thomas Fraser.
Mr. C. E. Groves.
Prof. Charles Lapworth.
Prof. Emerson Reynolds.
Capt. Creak.
Prof. J. A. McClelland.
Mr. R. Messel.
Mr. S. Ramanujan.
Mr. L. Doncaster.
Prof. J. Perry.
Sir Norman Lockyer.
Mr. J. G. Baker.

While on the Foreign List we have lost

Prof. Schwendener.
Prof. Voigt.
Prof. Rydberg.
Prof. Pfeffer.
Prof. Timiriazeff.
Prof. Hering.
Prof. Righi.

Our obituary notices contain detailed accounts of the achievements of these distinguished men; to-day I must content myself with the briefest possible reference to the most conspicuous of their contributions to Science.

Lord WALSINGHAM was a traveller and a keen sportsman, a distinguished entomologist, to whom the Natural History Museum owes a large collection of microlepidoptera.

Sir WILLIAM OSLER, by birth a Canadian, was for many years one of the leaders of Medical Science in America, where he did much to establish the great fame of the Johns Hopkins School of Medicine; when in 1905 he came to Oxford as Regius Professor of Medicine, he succeeded in winning, to a quite remarkable degree, the confidence and esteem of that University. He was eminent as a practitioner, as a teacher, and as a writer, and had a keen sympathy with literature as well as with Science.

Sir THOMAS FRASER was Professor of Materia Medica in the University of Edinburgh for forty-three years, and was one of the pioneers of experimental Pharmacology.

Mr. C. E. GROVES will long be remembered in connection with the invaluable Journal of the Chemical Society, with which he was associated, first as sub-editor and then as editor, for more than twenty years.

Prof. CHARLES LAPWORTH, the distinguished Professor of Geology at Birmingham, brought the study of the palæozoic rocks to the level of an exact science.

Prof. EMERSON REYNOLDS for his success as a teacher of Chemistry and for the importance of his discoveries in that Science. He added much to our knowledge of the properties of silicon and beryllium.

Captain CREAK was a veteran naval officer who had done much to improve the compass for Admiralty purposes and was an authority on the magnetism of ships and on terrestrial magnetism.

Physical science lost much by the death, at an early age, of my old pupil, Prof. J. A. McCLELLAND, who was one of the first research students at the Cavendish Laboratory. He had done valuable work on the passage of electricity through gases; he was a very successful professor at the Royal University of Ireland, and an energetic member of the advisory Committee for Scientific and Industrial Research.

Mr RUDOLPH MESSEL was distinguished for his success and originality in industrial Chemistry. He left to us by his will one of the most munificent bequests ever received by the Society.

Mr. S. RAMANUJAN, the first native of India to be elected a Fellow of our Society, was in some respects one of the most interesting names in the history of Mathematics. Self-taught as a mathematician, he sent, in 1913, a letter to Prof. G. H. Hardy, enunciating more than one hundred theorems; though not all of these were true, it was evidently the work of one who had a genius for Mathematics. Steps were taken to bring him to Cambridge, and he entered Trinity College in 1914; in the following three years he published twenty papers on pure Mathematics, some of them of great importance. Afterwards, his health broke down and he returned to India, where he died this year. He was a fellow of Trinity College: the first native of India who had ever won this distinction. Prof. G. H. Hardy has stated that "it is not extravagant to suppose that he might have become the greatest mathematician of his time."

The death of LEONARD DONCASTER at the early age of forty-two has cut short a career of exceptional promise and distinction. He took an active part in the early stages of Mendelism in this country, he made important contributions to the subject of sex-determination, and was a leader in cytology in this country. He was a very successful teacher, whose death Prof. Herdman has stated to be nothing else than a calamity to Liverpool University.

The loss of Prof. PERRY leaves a very noticeable gap in scientific circles. His enthusiasm and originality were as stimulating as they were delightful, and discussion never flagged when Perry was present. A pupil of Andrews and an assistant to Lord Kelvin, he went early in life to teach Science to the Japanese, and, in collaboration with Ayrton, poured out in the "eighties" a flood of researches on electrical subjects, so copious as to threaten to transfer the centre of electrical science to Japan. In conjunction with Armstrong and Ayrton, he established and determined the policy of Finsbury Technical College, an institution whose methods were as original as they were successful. He led a crusade on the proper way to teach Mathematics to students of Engineering, which has had a permanent, and, on the whole, a salutary effect on the methods adopted for that purpose. He had a long and intimate connection with the British Association, for which he was Treasurer for sixteen years. He did much for science by his personality, as well as by his researches.

Sir NORMAN LOCKYER had been a Fellow of the Society for more than fifty years, having been elected in 1869, immediately after the discovery of his method for revealing and studying the red flames in the solar atmosphere when the sun is not eclipsed. He took a very prominent part in the progress of Solar Physics for more than fifty years. He was fertile in ideas as well as in experiments, some of these have had much influence on the progress of Science, and even those which have not been confirmed by later experiments have aided the progress of knowledge by stimulating research and suggesting experiments which otherwise might not have been tried. He was the chief of no less than eight solar eclipse expeditions and organised the programme of several others. He was Professor of Astronomical Physics at the Royal College of Science and Director of the Solar Physics Observatory at South Kensington from 1885 to 1913, and when the observatory was transferred to Cambridge he established one of his own near Sidmouth. Among his other achievements is that of linking up Astronomy with Archæology, and thereby determining the date of construction of Stonehenge. He was indefatigable in urging the importance of Science for the welfare of the Nation and the necessity for the Government to assist and promote research and University Education. Last but not least are the services which he rendered to Science as Editor of 'Nature.'

Mr. J. G. BAKER, the veteran botanist, had been a Fellow of the Society for more than forty years, he had done splendid work for the herbarium at Kew and for systematic Botany.

Of those deceased on the Foreign list Dr. SCHWENDENER was the discoverer of the true nature of lichens and the founder of the study of the physiological anatomy of plants. Prof. VOIGT of Göttingen was an indefatigable worker at mathematical physics, the leading authority on the physics of crystals, a man of wide sympathies and an accomplished musician. Prof. RYDBERG'S discovery of the various series in the lines of the spectra of various elements has had a profound effect on the development of spectroscopy. Prof. PFEFFER was a great botanist whose researches on osmotic pressure made his name as familiar to physicists as it was to botanists. Prof. TIMIRIAZEFF was a botanist whose book on the "Life of the Plant" is a model for the statement of profound scientific truths in terms so clear and simple and eloquent as to be delightful to the ordinary reader. Prof. HERING was a physiologist well known for his work on colour blindness, while Prof. RIGHI had made important contributions to our knowledge of electrical waves and the passage of electricity through gases. He was one of the leading spirits in the great renascence of scientific research in Italy, which has been so conspicuous a feature in its recent history.

To turn now from those we have lost to those we have gained. On January 22 we were honoured by the presence, at a Special Meeting of the Society, of H.R.H. the Prince of Wales, who was then admitted into the Society. The accession to our list of Fellows of the Heir to the Throne is always regarded as a great honour to the Society, in this case the honour was exceptionally great, as we received one who, in addition to the prestige of his exalted position, has a splendid record of conspicuous and vital services to the Empire. Mr. H. A. L. Fisher and Sir J. G. Frazer have been elected Fellows of the Society under Statute XII.

The year has been memorable for the magnitude of the bequests which have been made to the Society: Dr. Messel, our late Fellow, has left to the Society a legacy which, it is estimated, will exceed £70,000, thus showing his goodwill to the Society and his appreciation of the value of pure science; this is the largest bequest ever made to the Society for general purposes. Under the will of Miss Fullarton we shall receive a substantial endowment for the Fullarton Fund for Studentships in Medical Science, and within the last few weeks we have received notice that under the will of Mr. Smithson the Society has been left the reversion of an estate which, it is estimated, will amount to between £18,000 and £20,000. In the case of the Messel and Smithson bequests, the Society is left some freedom with regard to the purposes for which they can be applied, a fact which greatly enhances their value to the Society. The amount received this year by bequest is the greatest on record—may that record soon be broken.

Our Assistant Secretary, Dr. Deller, has been appointed Academic Registrar to the University of London; we regret his departure, and he will carry with him to his new office the good wishes of the Fellows of our Society.

The rise in the cost of paper, printing, and binding has caused a large increase in the cost of publishing our 'Proceedings' and 'Transactions,' in spite of the fact, that owing to the interruption of research caused by the war, the number of papers communicated to the Society has not yet reached its normal value, it is, however, rapidly doing so and we must, I think, be prepared to face a continual increase in the cost of publication for the next few years. I am not sure that the majority of our Fellows realise the cost of publication of some of our papers. I may perhaps bring this home to them by mentioning that we have now one paper recommended for publication, which it is estimated will cost £500 to produce, and though this is exceptional, there are many papers which cost more than £100. Figures, such as these, show how important it is that contributors of papers should help the Society by rigid economy in the number of plates and by making their papers as concise as is consistent with clearness. Prolixity of statement is one of the most difficult things to combat; the referees can suggest the omission of irrelevant and superfluous matter—it is much more difficult for them to take action when the matter is relevant, but could be expressed in half the number of words required by the author.

It was said of one eminent man that he never used one word when forty would do; this quality may be useful under some circumstances, but it would not, I think, be appreciated by the officers of a Society that had to find the funds for the publication of papers by an author with this characteristic.

It has been urged that the days of publication of scientific papers through a Society are past, and that the proper vehicle of publication is a journal, such for example, as the 'Philosophical Magazine'; from the point of view of the dissemination of knowledge, this plan possesses advantages with regard to finance and convenience. These advantages would, in my opinion, be dearly purchased, for I think the reading of papers assists Science by making it more human, by bringing men who are working at a subject into contact with others who are working at it, from different, possibly from antagonistic points of view; again, I think having to read a paper before a Society tends to make an author take more pains to make it intelligible to those who are not specialists in the subject.

I do not mean to imply that all papers should be read before or even communicated to a Society—there are many that are best published independently—there is room for both methods of publication. It is important, however, that those published by a Society should be as accessible and have as wide a circulation as those published in other ways. In this respect I think there is room for reform; the circulation of our papers is not so large as it ought to be. No doubt, this is to some extent due to the fact that some of our publications include papers on many different subjects. 'Proceedings, B,' for example, contains papers on Botany, Physiology, Zoology, and Geology, and there are some who, though they would wish to possess the papers on one of these subjects, cannot afford the price required to pay for the other subjects as well. This, however, cannot be the only reason, for it does not apply to 'Proceedings, A,' which are as homogeneous as the 'Philosophical Magazine.' Perhaps the sale might be improved if the publications came out at a fixed date and at a fixed price, so as to make it easier for the bookseller to handle them.

I think that some improvement in our sales might possibly be effected and science benefited if there were some organisation, private or otherwise, for the sale of separate papers. The formation of a library, to include all papers on one of the great branches of science such as physics, requires a longer purse and more bookshelves than most are able to afford. But there are many, I think, who would like and could afford to form a fairly complete collection of the literature of one or more of the sub-divisions of the subject in which they are especially interested—say, for example, electrical waves or low temperature research. As lists of the papers in these sub-divisions are published at regular intervals by various agencies, it ought not to be difficult to arrange for the distribution of the separate papers if these could be obtained from the Societies.

In a few minutes I shall cease to be President of the Society. I should like to spend these in thanking the Fellows and Officers for the kindness, goodwill, and forbearance which they have extended to me in such full measure during my term of office. The position of President of the Royal Society would, under all circumstances, be one of great honour. I have found it, in addition, one of great pleasure; that it has been so is due entirely to your kindness. I wish to thank my colleagues, both those in office now and their predecessors, Sir Alfred Kempe, Sir Arthur Schuster, and Dr. Scott, who for five exceptionally arduous and trying years have borne so patiently with my many shortcomings, who have helped me in every way in their power, and, what I value no less highly, have granted me their sympathy and friendship. My thanks are due to the Assistant Secretaries, Mr. Harrison and Dr. Deller, and to every member of the staff. To the kindness of the Fellows, I owe it that I take away with me, when I retire from office, recollections of unmixed pleasure, recollections which will be a solace and joy to me for the rest of my life.

I congratulate and welcome my successor. I think I shall not be accused of rash speculation if I assume that he is a man of preeminent distinction in Physiology, and one who has won the confidence and esteem of workers in every branch of Science.

We now proceed to the distribution of the Medals.

The Copley Medal is awarded to Dr. Horace T. Brown in recognition of his work on the chemistry of carbohydrates, on the assimilation of atmospheric carbon dioxide by leaves, and on gaseous diffusion through small apertures.

As was the case with Pasteur, so with Horace Brown; problems and difficulties arising out of a branch of the fermentation industry supplied the incentive to investigations which are of fundamental importance in Chemistry and Botany.

His earliest investigations dealt with one of the diseases of beer, and in 1871, at a period when modern bacteriological technique was unknown, he gained a complete knowledge of the life-history and chemical activities of *Saccharobacillus Pastorianus,* which at that time was responsible for most of the trouble met with in beer during maturation, and devised means to combat the waste caused by this organism.

The year 1877 marked the commencement of his exhaustive study of the chemistry of starch, which led to the publication of a series of papers dealing with the products of the hydrolysis of starch by diastase—wherein it is shown that the action may be viewed as involving the successive removal of maltose from dextrins of diminishing complexity—the molecular weight of starch and the structure of the starch molecule.

In 1885 his attention was turned to the study of the chemical and physical changes involved in the conversion of barley into malt, with the result that in 1890 he was in a position to give in his paper, entitled "Researches on some of the *Gramineæ,*" an explanation of the chemical and morphological changes which occur in the barley grain during the early stages of germination. This investigation, concerned mainly with the transformation and migration of the reserve carbohydrate constituents of the grain, was followed by one no less remarkable, in which he traced the relation of the sugars and starch existing in the leaves of certain plants from their inception to their translocation. The paper embodying an account of this research was published in 1893 under the title "Contribution to the Chemistry and Physiology of Foliage Leaves."

A few years later the study of the changes occurring in the green leaf during photosynthesis was extended to an investigation of difficulties connected with the absorption of carbon dioxide through the stomata of the leaf, which was found to be many times greater than expected from the operation of the law of gaseous diffusion as then understood.

In his paper on "The Principles of Diffusion, their Analogies and Applications," published in 1918, he shows how important are the results which may accrue to physical and biological science from a continued study and application of the principles of diffusion.

The Rumford Medal is awarded to Lord Rayleigh.

Lord Rayleigh is distinguished for his researches into the properties of gases at high vacua, and his work has opened the way to many valuable investigations.

Some years ago he made a number of interesting observations on the afterglow in various gases noticeable after the cessation of an electric discharge, and these led, in 1911, to his Bakerian Lecture on the "Afterglow of Nitrogen." The investigation thus started has proved the subject of much of his recent work, and in a series of most valuable papers he has studied the properties of the gas in which this afterglow is visible. This work has continued almost up to the present time; the papers show great experimental skill, the results are confirmed by numerous experiments, and the whole series constitute a very real addition to knowledge.

Quite recently he has published a new series of papers, culminating in the Bakerian Lecture of the current year. These deal with a subject which was investigated mathematically by his distinguished father nearly fifty years ago.

Our late President then showed how the blue of the sky was caused by the scattering of light by small particles in the atmosphere; his son has given a convincing demonstration of this in his paper published in February of 1918, on the "Scattering of Dust-free Air; Reproduction of the Blue Sky," and in those which have followed.

A Royal Medal is awarded to Prof. Godfrey Harold Hardy.

Prof. Hardy is well known both in this country and on the Continent for his researches in pure mathematics, particularly in the analytic theory of numbers and allied subjects. Immediately after taking his degree at Cambridge he engaged in a series of researches on the theory of functions of a real variable, from which results of the greatest importance and generality were obtained, at first by himself alone and later in collaboration with Mr. J. E. Littlewood. Perhaps his most remarkable work is his more recent work on Partitions, carried out in collaboration with the late Mr. S. Ramanujan, especially a paper on "Asymptotic Formulæ in Combinatory Analysis" ('Proc. Lond. Math. Soc.'), in which a system of approximations are obtained for $p(n)$, the number of unrestricted partitions of n and associated functions. The ingenuity of the method and the accuracy of the results are equally remarkable. For p (200) the authors' approximate formula gives the value 3,972,999,029,388·004, from which the true value differs by 0·004, an error of 1 in 10^{15}.

Among the more important researches of which Prof. Hardy is sole author may be mentioned papers on Dirichlets' Divisor Problem, on the representation of numbers as the sum of n squares, on the roots of the Riemann ζ-function, and on non-differentiable functions.

A Royal Medal is awarded to Dr. William Bateson.

Dr. Bateson is universally recognised as a leading authority on genetics and and has done more than anyone else to put that branch of inquiry on a scientific basis. The work that stands to his name is, however, but a fraction of that which he has inspired wherever biological research is prosecuted. The following is a record of his work during the last 10 years.

In conjunction with Prof. Punnett he worked out in detail one of the earliest cases of sex-linked inheritance. The general principle involved, that one sex is homozygous and the other heterozygous for a definite sex factor, is now generally accepted by geneticists. This principle was first stated by these authors in 1908. ('Journ. of Genetics,' 1910.)

Peculiar association of genetic factors in gametogenesis had previously been discovered by the same authors and described under the terms "coupling" and "repulsion." In 1911 they published two papers ('Proc. Roy. Soc.' and 'Journ. of Genetics'), which proved that these phenomena are part of a more general phenomenon of linkage, the orderly nature of which was pointed out. Since these papers appeared the phenomen has been shown by various workers to be a wide-spread one, both in animals and plants; and during the past few years it has formed the basis of striking advances in genetical studies through the work of American observers on the favourable material of the little fruit fly, *Drosophila*.

Three papers by Bateson and C. Pellew ('Journ. of Genetics,' 1915, and 'Proc. Roy. Soc.'—*ibid.*, 1920) record a discovery of high interest and importance, viz., that the germ cells of the same plant may vary in their genetic properties. It is further pointed out that the variation proceeds in an orderly way from the base of the plant to the apex. The conception is a novel one, and is bound to have great influence on the development of genetical theory.

A paper by Bateson and Ida Sutton ('Journ. of Genetics,' 1919) records the discovery that in *Begonia Davisii*, a genuine wild species, the ovules bear the factor for single flowers, while the pollen is genetically double. The paper is a striking contribution to a principle insisted on by Bateson for many years, viz., that the male and female sides of a hermaphrodite plant may vary in their genetical properties.

The Davy Medal is awarded to Mr. Charles Thomas Heycock, who in collaboration with the late Mr. F. H. Neville published a remarkable series of papers, all characterised alike by great experimental skill and originality, as well as by concise yet simple mathematical treatment. The molecular complexity of metals when dissolved in other metals, the composition and constitution of binary and ternary alloys, and the part which the eutectics play during the cooling of a complex alloy were clearly revealed, not only by freezing point methods, but by a most ingenious method of chilling, as well as by etching by means of many new reagents.

These researches have added very greatly, not only to our theoretical knowledge and conceptions, but have been of the greatest importance to industrial metallurgy in many directions.

The Darwin Medal is awarded to Prof. Roland Harry Biffen.

Prof. Biffen has worked out the inheritance of practically all the obvious characters of wheat and barley. Perhaps his best-known work is that on the inheritance of strength in wheat and on the inheritance of susceptibility and resistance to yellow rust in wheat.

Biffen has broken entirely new ground in his work on the inheritance of disease. The reason why he has succeeded in both these difficult problems, while others have failed, is that he possesses quite extraordinary imaginative insight and powers of observation. Not only is he a capable investigator, but he has proved himself to be a successful teacher who stimulates research in his students.

Biffen's activity is not by any means to be measured by his published work. Two of his new wheats—"Little Joss," which owes its value to its immunity from rust, and "Yeoman," which combines high yield with first-class baking quality—are among the most popular wheats in the country, and together account for something like a third or even a half of the wheat crop of England.

The Hughes Medal is awarded to Prof. Owen Williams Richardson for his researches on the passage of electricity through gases and especially for those relating to the emission of electrons from hot bodies, a subject which he has made his own and christened Thermoionics. The subject is of great industrial as well as of scientific importance.